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Introduction to UKBIC & Benefits and Challenges of CT scanning Li-ion Batteries

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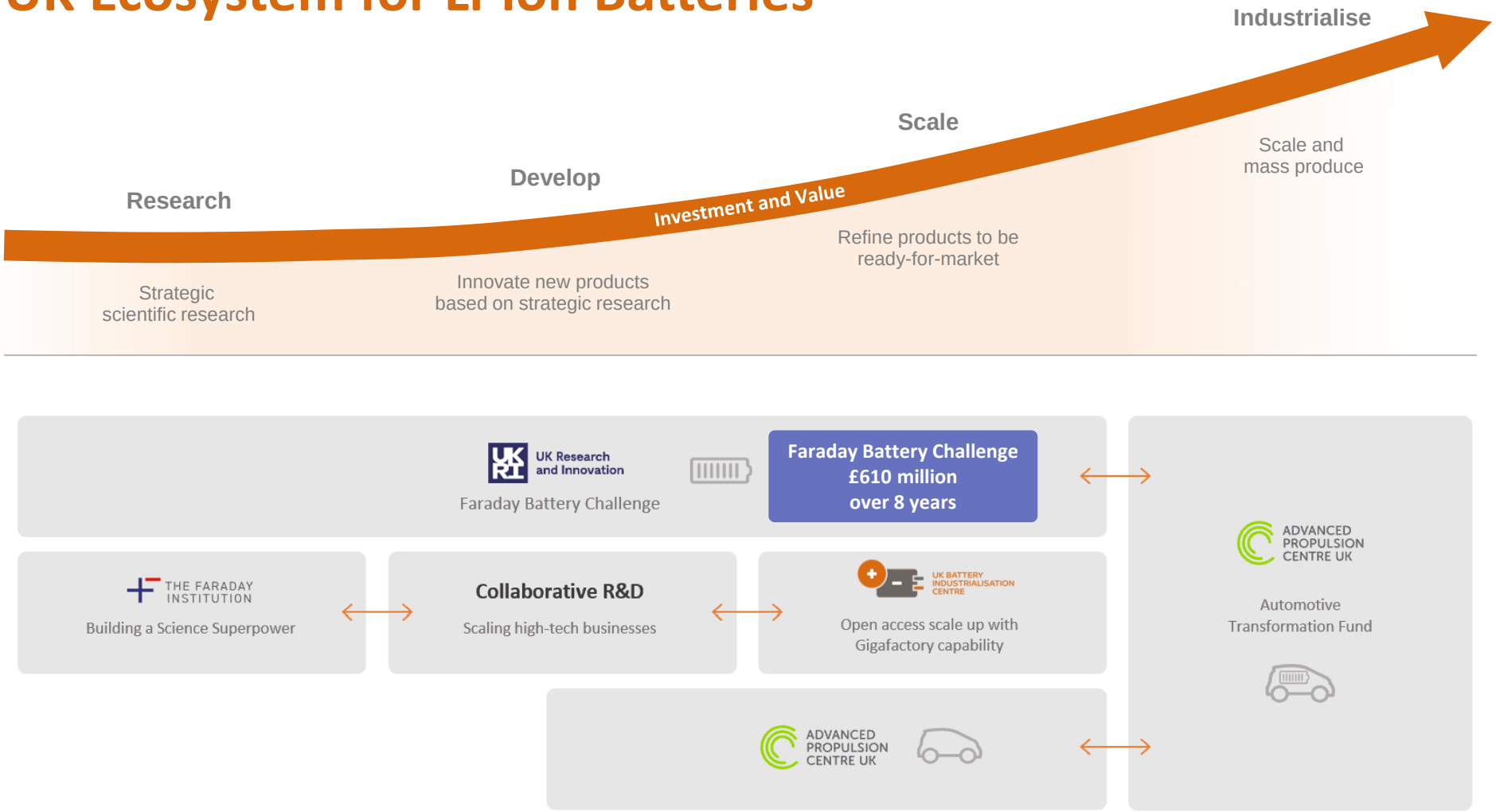
The UK Ecosystem for Li-ion Batteries



Source: Advanced Propulsion Centre

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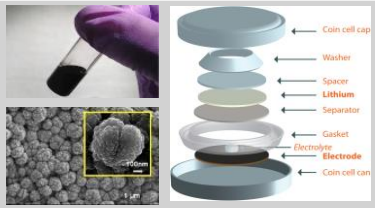
Bridging the Gap from R&D to Mass Production

UKBIC scope

Volume, TRL, MRL

	Gramme Scale	Kilogramme Scale	Tonne Scale	Giga Scale
				
Characteristic	▪ University scale research labs using small quantities of handmade materials ▪ Fundamental materials research ▪ Initial half-cell experiments at coin cell scale	▪ Corporate R&D pilot line or university/Catapult centre ▪ Used to demonstrate early scalability of materials to full size cell ▪ Develop and demonstrate electrode mixtures, deposition processes and cell formats	▪ Full-scale GWh/yr manufacturing facilities used at low output rate ▪ Used to develop and validate materials, cell design, manufacturing processes and parameters at industry rates prior to full plant investment	▪ Full-scale, high volume manufacturing plant. Typically 6-50GWh/year ▪ Used to deliver very large volumes of cells with no variation or flexibility to chemistry, format or quality ▪ Cost/kWh and process consistency are critical

Technology readiness	TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9
	Principles & research	Explore applications	Analytical experiments	Validation & requirements	Design & performance	Model & prototype	Performance & testing	Test & demonstrate	Real world launch

Manufacturing readiness	MRL 1	MRL 2	MRL 3	MRL 4	MRL 5	MRL 6	MRL 7	MRL 8	MRL 9	MRL 10
	Implication & materials	Identify processes	Proof of concept	Identify technology & test	Prototype materials, tools & skills	Processes & detailed costs	Pilot line & materials	Process maturity demonstration	Manufacturing processes proven	Production ready
	Material solution analysis				Technology development		Engineering & manufacturing development		Production & deployment	Operation & support

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Based in Coventry

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UK Battery Industrialisation Centre (UKBIC)

Electrode - anode	Cell Assembly (Pouch, Cylindrical)	Formation, Age & Test	Module	Pack
Electrode - cathode				

Mixing → Coating and Drying → Calendering → Slitting → Assembly → Formation, Age & Test → Agile Module Assembly → Agile Pack Assembly

- Manufacturing research facility based near Coventry
- Open to organisations looking to scale technology in the UK
- Access giga-scale equipment to de-risk commercial investment
- Trial and validation at industrial scale, speed and quality
- Available to any sectors looking to scale battery technologies
- Customers retain full ownership of their IP developed at UKBIC
- Delivering skills, training and knowledge transfer for the UK

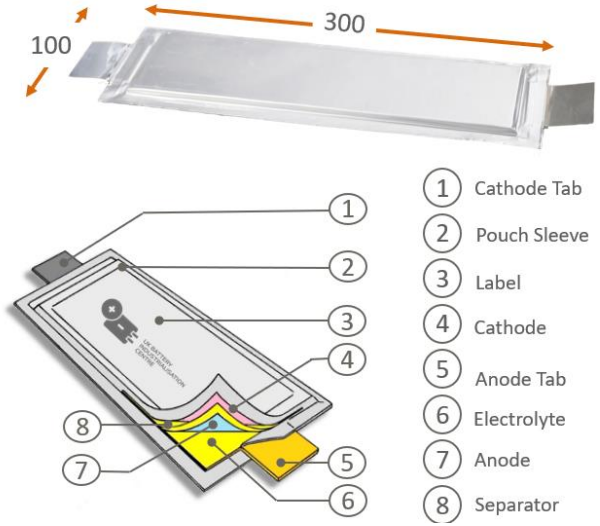
CT Scanning Li-ion battery cells

- Types of cell suitable for CT Scanning

Cylindrical Cell - 21700

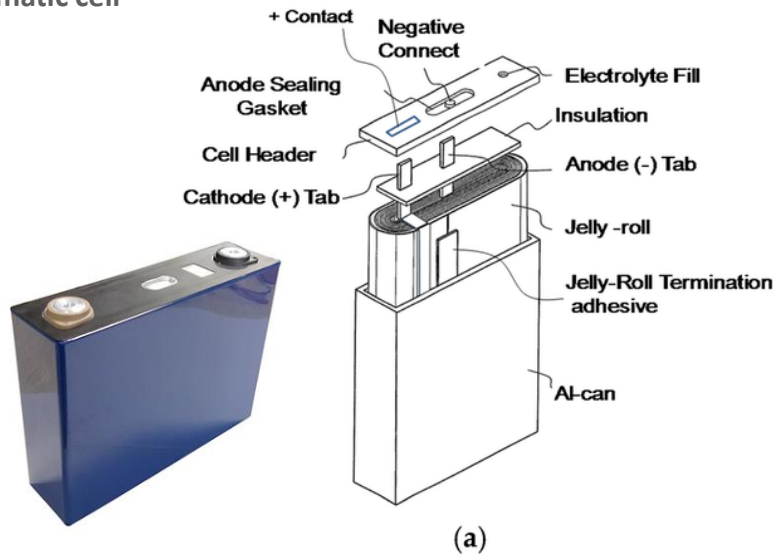
1. Can
2. Cap with CID, vent and Gasket
3. Coil Pack (jelly roll)
4. Top insulation disc
5. Bottom Insulation disc
6. External Insulation Ring
7. Outer sleeve

Pouch Cell



1. Cathode Tab
2. Pouch Sleeve
3. Label
4. Cathode
5. Anode Tab
6. Electrolyte
7. Anode
8. Separator

Prismatic cell



https://www.onecharge.biz/lithium-cell-format/

Landini, Stefano. (2019). A Review of Phase Change Materials for the Thermal Management and Isothermalisation of Lithium-Ion Cells. The Journal of Energy Storage. 25. 1000887. 10.1016/j.est.2019.100887.

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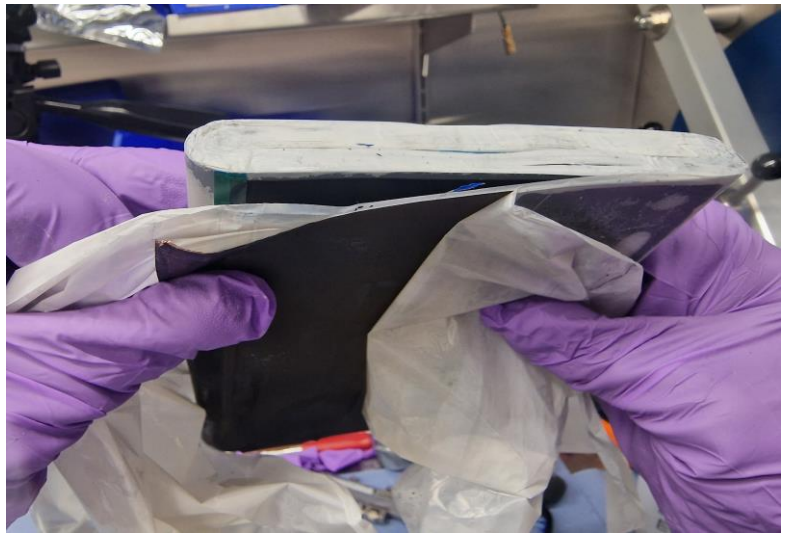
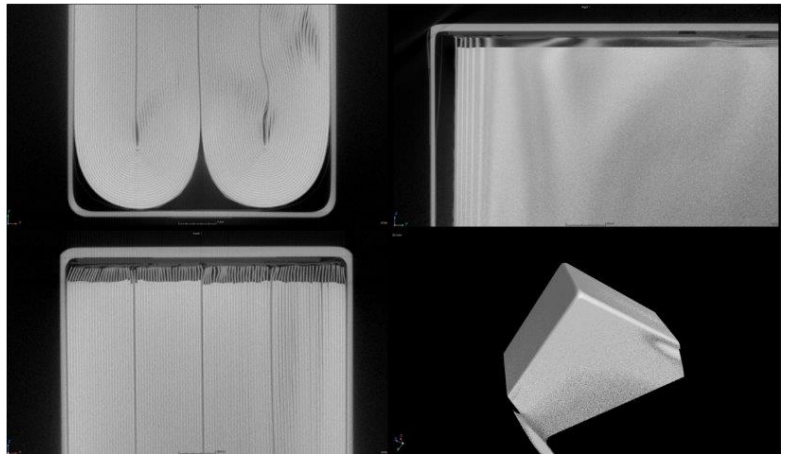
CT Scanning vs Cell Teardown





- CT scanning is an essential part of the cell teardown process
  - Understand geometry and risks of the teardown process
- Cell teardown destroys the cell whereas CT is non destructive and can be used in other testing or be used as a good cell
- Movement of cell contents in teardown process can affect analysis results
- Teardowns increase risk of operator exposure to noxious substances (electrolyte) and short circuit
- CT scanning is up to 5x faster than Cell teardowns

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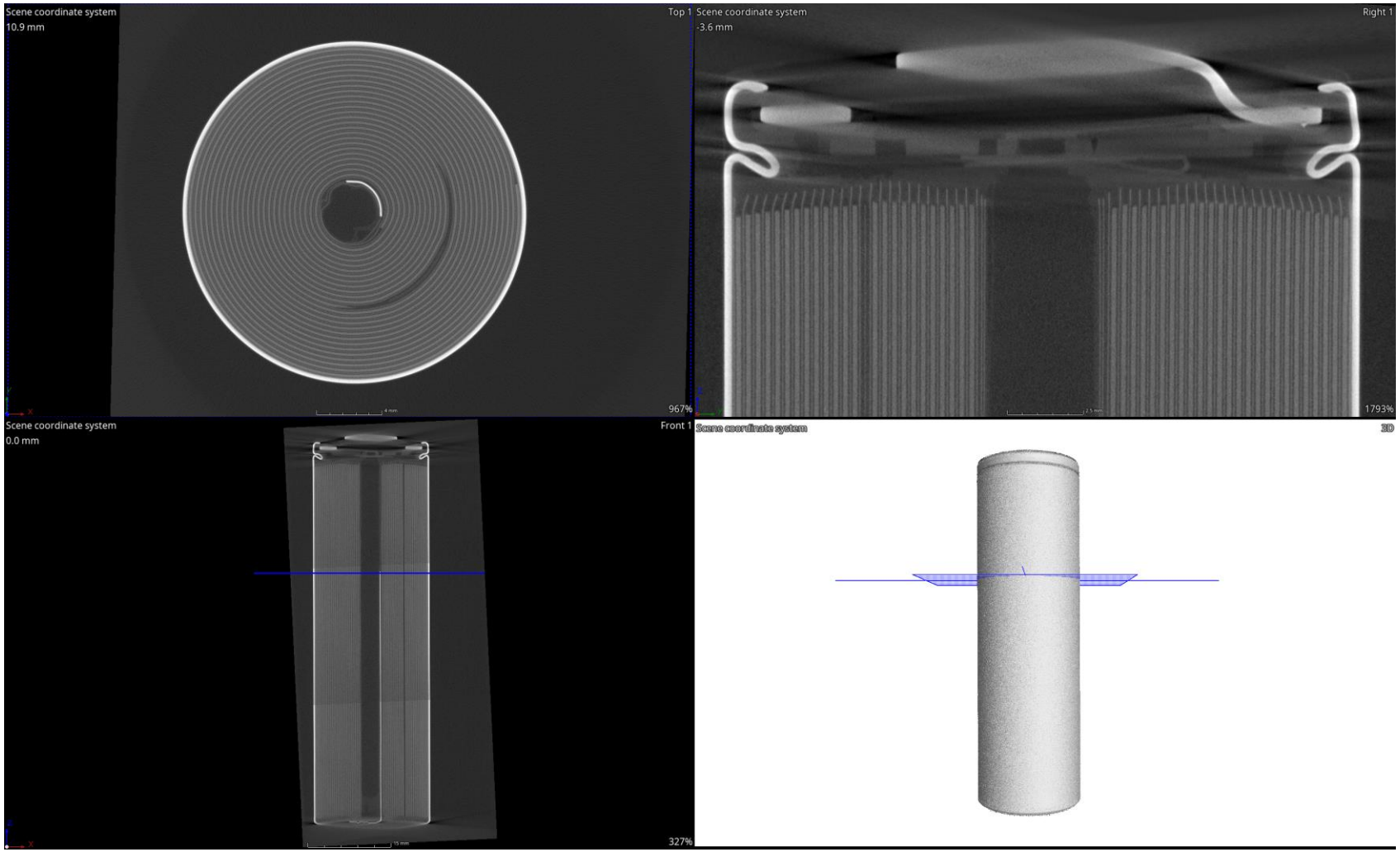
Good cell – anode tab



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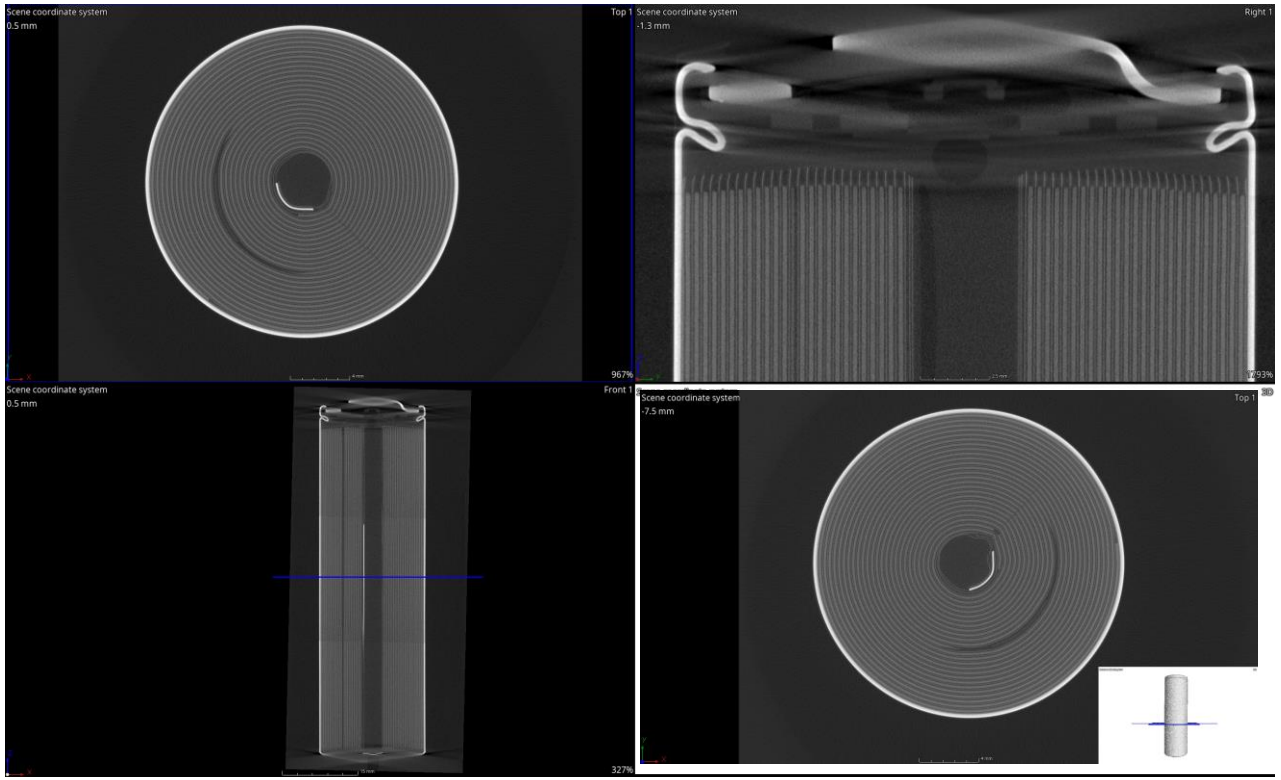
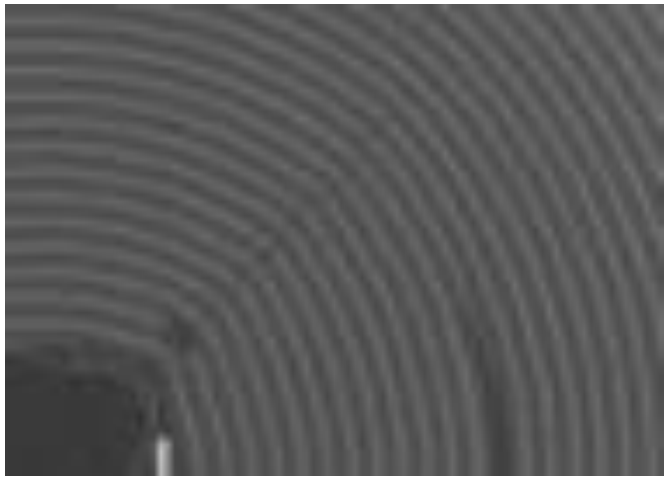
Cracking





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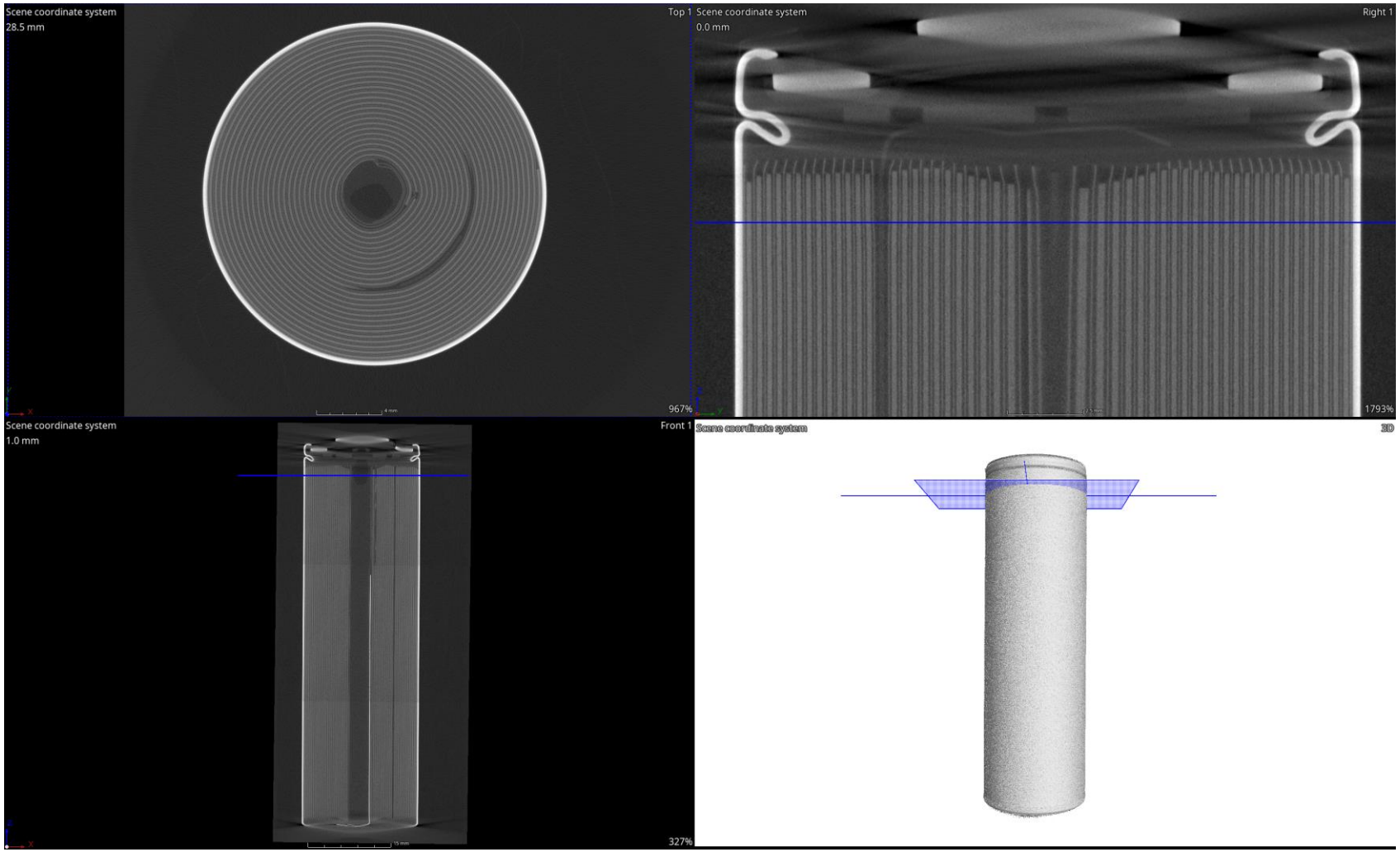
Popped CID



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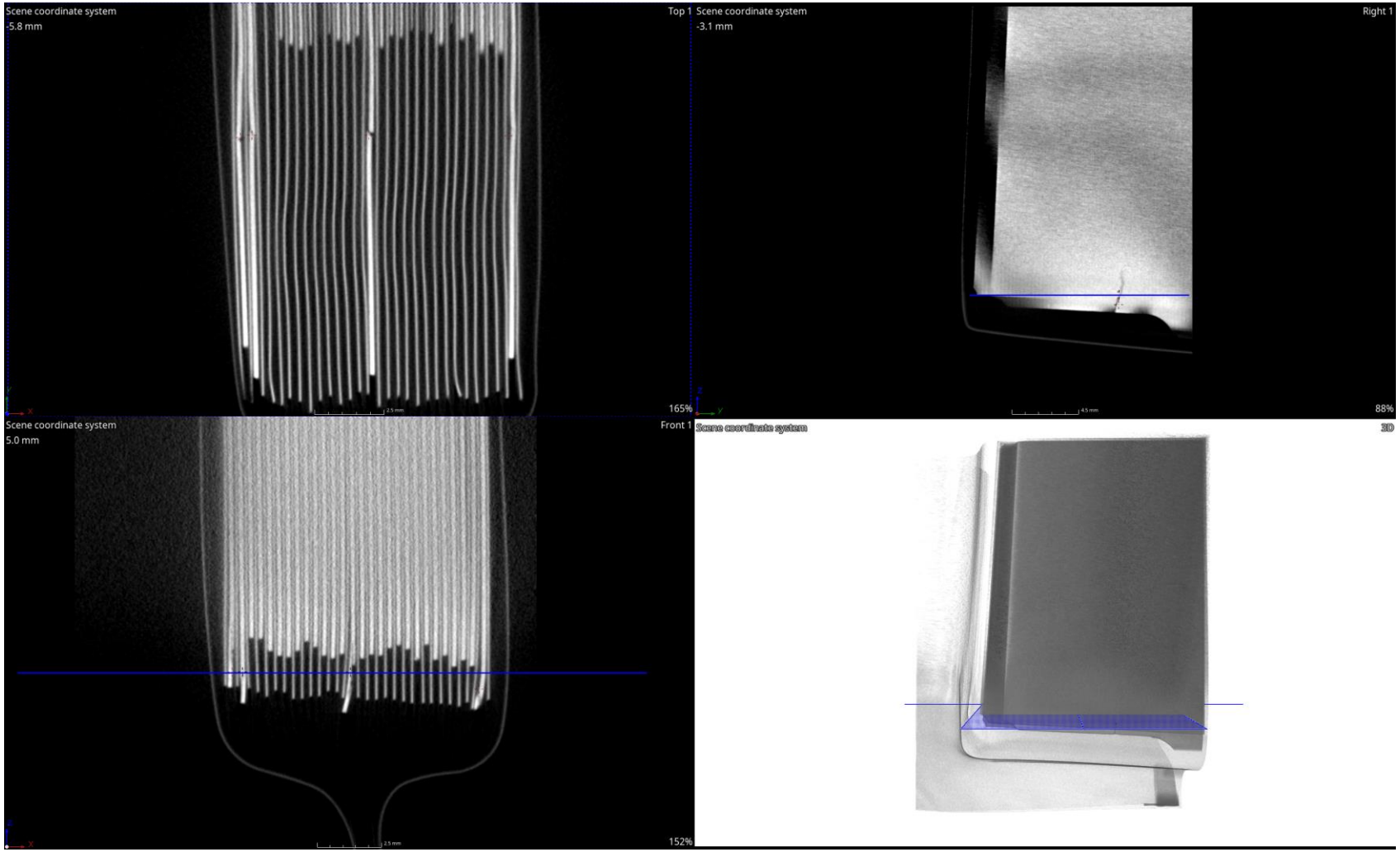
Pouch corner – defects inspection



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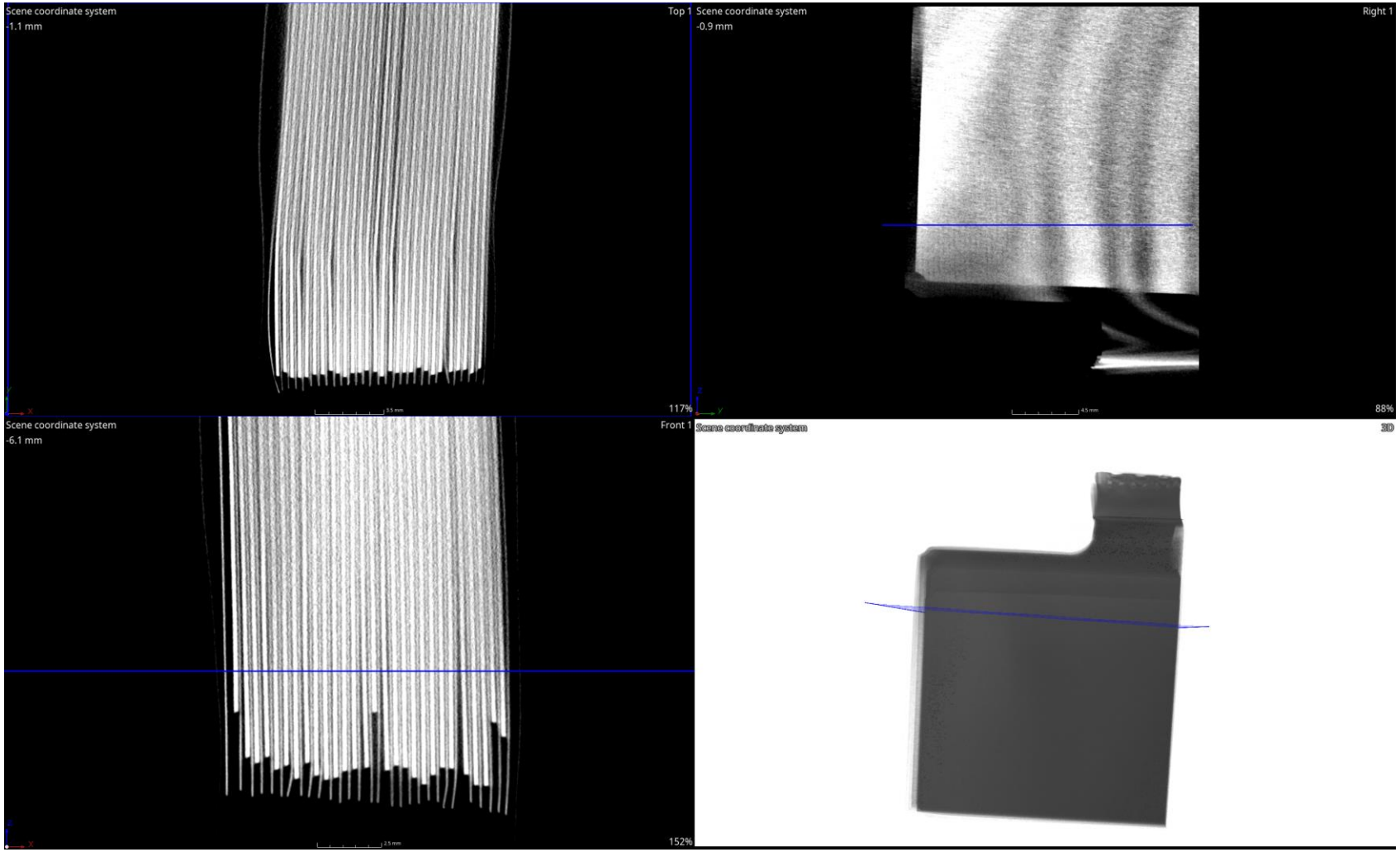
Pouch corner – alignment check



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CT Scanning Autosampler

- The autosampler feature on the Waygate CT scanner installed at UKBIC
  - Useful for cylindrical cells
  - Easily programmable
  - Reduces the need for highly skilled operators
  - Speeds up the cell scanning process time
  - Can be run without supervision – lights out functionality

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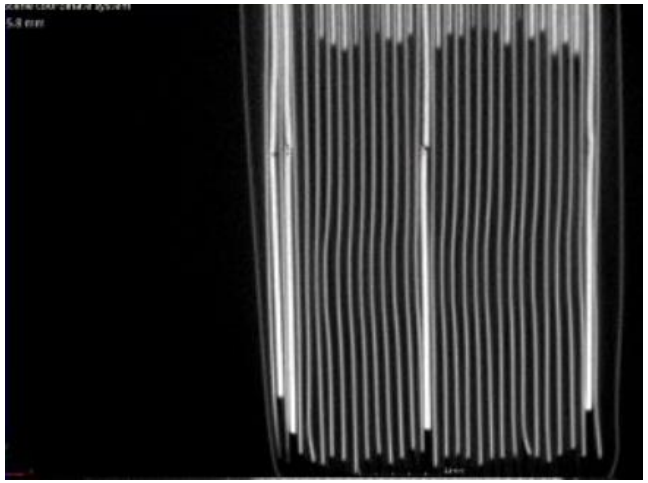
CT Scanning challenges

- CT scanning is still an off line process and takes time
  - On line scanning would be a big step forward and is being developed
- The UKBIC scanner can find it difficult to see the individual layers in anode due to lack of contrast
  - Could be resolved by having a higher resolution but takes longer. A higher flux scanner is available which will give better images
- Use of AI in industrial applications of CT scanning is lagging academia
  - Automated Defect Recognition (ADR) assisted by AI will speed up data analysis.
  - Requires the availability of large amounts of data to create the required models

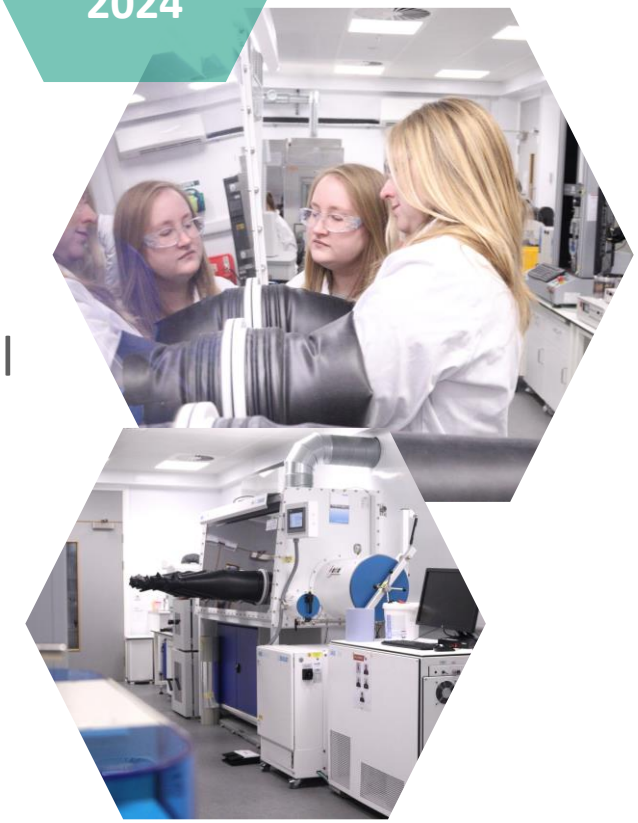


Battery Development Laboratory

Extensive analytical equipment split into five areas:

- **Characterisation**
  Includes: morphology, crystal structure and elemental composition using PSD, XRD, ICP, Raman, NMR & SEM
- **Processing**
  Includes: small scale mixing, drawdown and coin cell assembly enabling electrochemistry trials
- **Electrochemistry**
  Includes: electrochemical analysis of coin, pouch, and cylindrical cells
- **Forensics**
  Specialist glovebox equipped with thermal and optical cameras
- **CT Scanning**
  Non-destructive failure analysis

Coming Autumn 2024



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Skills, Learning and People Development

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Skills Challenge: Finding the workforce

Allied industries

Electrode

Electronics

Cell assembly

Data analysis

FA&T

Assembly line

Module & pack

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Training at UKBIC

- We provide bespoke training packages to meet customer needs
- **Introduction to Battery Manufacturing course, 23rd – 24th 2024** – bookable via our website

Awareness training

- Substance Awareness
- Clean and Dry Rooms in Battery Manufacturing

Introduction courses to...

- Battery Manufacturing Processes
- Electrode Processes
- Cell Assembly
- Formation, Ageing and Testing Processes
- Module and Pack

Sustainability Training

- Fundamentals of Sustain Manufacturing
- Environmental Impact and Assessment in Battery Manufacturing

Design courses

- Operating Principles of Battery Management Systems
- Familiarisation of Battery Module and Pack Design
- Introduction to Designing Sustainable Batteries

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